WAVETEK® INDIANA INC.

66 N. 1st AVENUE, P.O. BOX 190

BEECH GROVE, INDIANA 46107

317—783-3221

MODEL 1951
DISPLAY
OSCILLOSCOPE

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Serial No._____

INSTRUCTION MANUAL

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VIKING LABORATORIES INC.

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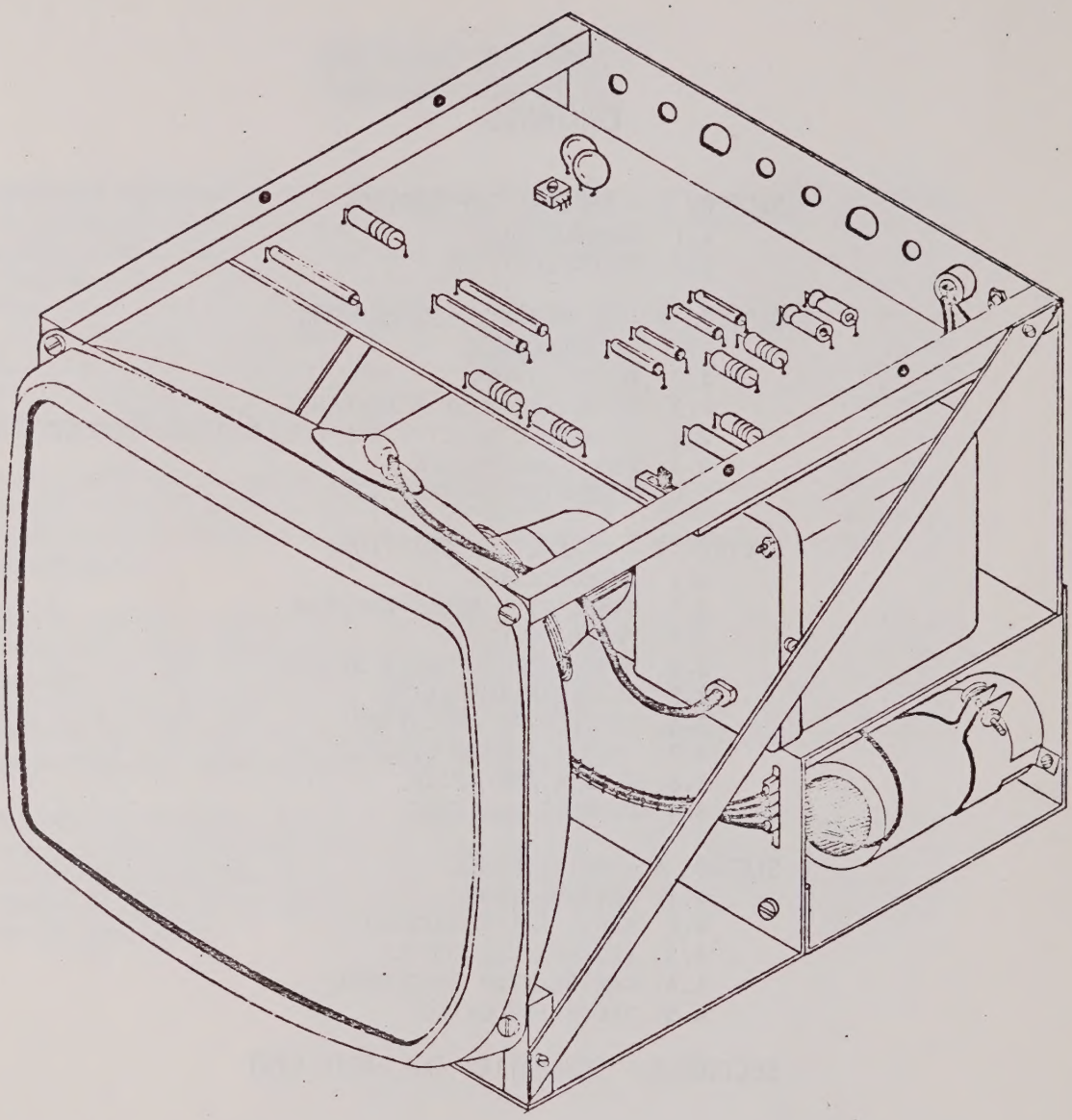

FIGURE i WAVETEK DISPLAY OSCILLOSCOPE

SCOPE OF THIS MANUAL

This manual provides descriptive material and instructions for the installation, operation, maintenance, and repair of the WAVETEK Model 1951 Display Oscilloscope.

SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

The Wavetek Model 1951 is a versatile, low cost, compact, large screen, solid-state X-Y display oscilloscope module designed for general purpose OEM applications. The instrument frontal dimensions are only slightly larger than the outside dimensions of the CRT.

For these applications, several features have been incorporated in this large, easy-to-read display:

1. Optional, external controls can be easily added for Intensity, Vertical Gain, Vertical Position, Horizontal Gain, and Horizontal Position.
2. Intensity Modulation circuit with a Contrast control independent of the intensity control; polarity internally reversible.
3. Spot blanking circuit to prevent burning of CRT phosphor.
4. Excellent full-scan linearity.
5. Vertical-deflection polarity internally reversible.
6. Horizontal-deflection polarity internally reversible.
7. Primary voltage internally changeable to 230 VAC.

The Model 1951's most outstanding feature is its mechanical strength and electrical reliability. In the event servicing is required in the field, maintenance personnel will find that the unit's single P.C. board construction, organized component layout, plus a comprehensive instruction manual all contribute in making this instrument easy to service, even for the relatively inexperienced technician.

1.2 SPECIFICATIONS

DISPLAY

CRT		12" diagonal (30 cm), useable area 18 cm x 24 cm
Phosphor		P1 Medium persistence - Green
	OPTIONS	P4 Medium short persistence - White P7 Long persistence - Blue Other phosphors available on special order
DEFLECTION		Magnetic
ACCELERATOR VOLTAGE		9 kV Nominal

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VERTICAL

Sensitivity	Continuously adjustable from less than 1.5 V to over 150 V for 18 cm deflection
Input Impedance	≥50 Kilohm
Bandwidth	DC to greater than 15 kHz (3 dB point)
Linearity	5% (center 15 cm)
Coupling	DC
Input Provisions	Input leads connect to printed-circuit board by means of a 15-pin harness connector (supplied).
Drift	Less than 3/4 cm/8 hr. (at a constant ambient temperature after ½ hour warmup)
Polarity	Positive voltage causes upward deflection; internally reversible
Position	Continuously adjustable over approximately 2 times full screen

HORIZONTAL

Sensitivity	Continuously adjustable from less than 1.8 V to over 150 V for 24 cm deflection
Input Impedance	Greater than 320 Kilohm
Bandwidth	DC to greater than 1.5 kHz (center 21 cm) (3 dB point)
Linearity	3% (24 cm)
Coupling	DC
Input Provisions	Input leads connect to printed-circuit board by means of the 15-pin harness connector.
Drift	Less than 3/4 cm/8 hr. (at a constant ambient temperature after ½ hour warm-up)
Polarity	Positive voltage deflects trace to right; internally reversible.
Position	Continuously adjustable over approximately 2 times full screen.

INTENSITY MODULATION

Sensitivity	Adjustable with rear-panel control from less than 1 V peak-to-peak to more than 10 V peak-to-peak for full modulation.
Polarity	Positive signal brightens trace; internally reversible.
Input Impedance	>10 Kilohm
Input Connector	BNC, rear panel
Bandwidth	Flat from DC to 1 MHz, 3 dB down at 3.5 MHz, 10 dB down at 10 MHz.

PROTECTION CIRCUIT . . . . . Prevents burning of the CRT by blanking beam when horizontal signal is less than approximately 4 divisions (60 Hz rate). When operating at a slower rate, or for servicing, an internally mounted switch can be used to eliminate the protection circuit. The blanking circuit can be internally jumpered to operate on vertical rather than horizontal signals.

CONTROLS . . . . . The intensity, vertical gain and position, and horizontal gain and position controls are mounted internally on the main printed-circuit board. External controls, if desired, can be connected to the 15-pin harness connector, with proper setting of the corresponding internal controls.

POWER REQUIRED . . . . . 115 VAC ±10% 50/60 Hz (approximately 75 W) to a 3-pin plug on the rear panel (mating connector supplied). Internally changeable to 230 VAC.

MECHANICAL

Dimensions	9 25/32" high x 11 5/8" wide x 13 3/4" long
Weight	24½ pounds

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ACCESSORIES SUPPLIED	Instruction manual 3-pin AC connector with contacts 15-pin input and control connector with contacts
ACCESSORIES AVAILABLE	Power supply extension cable for remote power supply operation; customer specify length.

SECTION 2
OPERATING INSTRUCTIONS

2.1 INTRODUCTION

This section covers mechanical installation, description of rear panel, PC-board controls, 230 V conversion, and operating instructions.

2.2 INSTALLATION

2.2.1 Initial Inspection

After unpacking, the instrument should be inspected for physical damage. A procedure for checking the electrical performance is given in Section 4. The shipping container and the packing material should be saved in case it becomes necessary to reship the unit.

If there is physical damage or the unit does not meet the electrical performance checks, notify the nearest Wavetek area representative or the factory in Indiana. If the shipping container shows damage, notify the carrier. Retain the shipping container and packing material for the carrier's inspection. In either case, the factory or area representative will arrange for immediate repair or replacement of your instrument, without waiting for damage claim settlements.

2.2.2 Mechanical Installation

The Model 1951 is shipped as a complete assembly, and can be installed in a system as received. A number of mounting holes have been provided on the chassis. If necessary, other holes can be added to the chassis by the user (care should be taken when adding additional mounting holes that harness or, electrical components are not damaged).

If necessary, the low-voltage power supply can be removed from the main chassis and mounted in a remote location. An interconnection cable is available from the factory; specify required length when ordering. Figure 2-2 shows the low-voltage supply removed from the main assembly.

2.3 DESCRIPTION OF REAR PANEL

The following is a description of the controls and inputs located on instrument rear panel. In addition, the rear of the unit has a number of mounting holes for optional input connectors and controls; these optional items are supplied by the user.

AC INPUT - 3-pin plug (mating connector supplied) applies AC input power plus external ground to instrument; input normally 115 VAC 50/60 Hz, but internally changeable to 230 VAC 50/60 Hz.

FUSE - In series with AC input to instrument; 2A slo-blo for 115 VAC, or 1A slo-blo for 230 VAC.

INTENSITY MOD. INPUT - BNC connector for Intensity (Z-axis) signal input. Positive signal brightens trace (internally reversible by two jumpers on P.C. Board).

CONTRAST - This control emphasizes or deemphasizes the variation in brightness which is produced by an intensity-modulation input signal.

NOTE: The intensity-modulation input and its associated contrast control are installed on the rear of the instrument

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because of high-frequency considerations. This control and input can be moved to a remote location by the user at a sacrifice in frequency response of the intensity-modulation circuit.

2.4 PRINTED-CIRCUIT BOARD CONTROLS & CONNECTIONS

The following is a description of controls and connectors located on the instrument main printed-circuit board. See Figure 2-3.

AUTO BLANKING SW. - In the ON position, the Auto Blanking circuit blanks CRT beam in the absence of a Horizontal signal (can be internally jumpered to operate on Vertical signal) to prevent burning of CRT phosphor. In the OFF position, the Blanking circuit is disabled to allow operation at slow-sweep rates or to aid in servicing. Caution: Care must be taken in the OFF position to prevent burning the CRT phosphor.

FOCUS - Controls the sharpness of the trace.

HIGH VOLTAGE ADJ. - Calibrates voltage level.

INTENSITY LIMIT - Adjusts brightness of the trace. If optional external Intensity control is used, the Intensity Limit control sets the maximum brightness level.

VERTICAL BALANCE - Controls Vertical position of trace on the scope screen. Set control to approximately mid-range if optional Vertical Position control is used.

VERTICAL GAIN - Adjusts the V/cm Vertical sensitivity; set for maximum if optional Vertical Gain control is used.

HORIZONTAL GAIN - Adjusts the V/cm Horizontal sensitivity. This control may be omitted from the PC Board when the optional external Gain control is used.

HORIZONTAL BALANCE - Controls Horizontal position of trace on the scope screen; set to approximately mid-range when optional Horizontal Position control is used.

HORIZONTAL LINEARITY - Calibrates linearity of the Horizontal display.

HUM CANCEL - Minimizes effect of AC hum on Horizontal display.

15-PIN CONNECTOR - Figure 2-3 shows the location of this connector and the typical hook-up of external controls. Shielded cables should be used on all signal-input connections. A 15 - pin mating connector and pins are supplied with each instrument.

2.5 230 V CONVERSION

Should the instrument require conversion to 230 VAC operation, the following procedure should be followed:

Remove the instrument's low-voltage power supply, by removing six screws as shown in Figure 2-2. Figure 2-1 shows the instrument transformer wired for 115 VAC. To convert to 230 V operation, remove the brown wire from the fuseholder and the violet wire from the terminal strip. The brown and violet wires should then be soldered to the unused terminal on the terminal strip. The fuse should be changed to 1A slo-blo. The reverse procedure should be followed for conversion to 115 V operation.

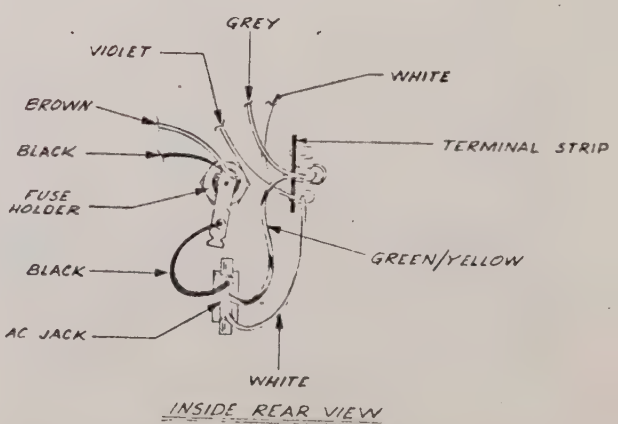

Figure 2-1. 230 V Conversion

2.6 OPERATING INSTRUCTIONS

Before operating the instrument, the user should study Figure 2-3 to determine what inputs and controls are needed for his application. Appropriate connections should be made using the 15-pin connector and pins supplied. The instrument can be operated with no external controls; or, with any combination of internal and external controls. The user's application determines what optional controls, if any, are used.

If an external Intensity control is not used, a jumper should be connected between pins 3 and 4. Pins 1 and 2 can be used for connecting a pilot light; approximately 20 mA is available at this point for driving an LED. If an LED is not used, a jumper must be connected between pins 1 and 2.

The Display can be operated with no external controls. Vertical and Horizontal signals are the only connections required. The amplitude and position of the displayed signals can be controlled by the position BALANCE and GAIN controls mounted on the printed-circuit board. If external controls are used, the internal controls can be used as calibration controls.

Figure 2-3 also shows connections for the Auto-Blanking circuit. As shipped from the factory, the instrument will automatically blank the display in the event no Horizontal signal is applied. This prevents a stationary spot from burning the face of the CRT. As shown in Figure 2-3, the wiring (one jumper) can be changed to blank the display if the Vertical signal is lost. In addition, the Auto-Blanking can be disabled by the Auto-Blanking switch for slow-sweep rates or for servicing.

CAUTION: Care must be taken to prevent burning the face of the CRT.

Figure 2-3 also shows the intensity modulation input wired for negative blanking. It can be rewired (two jumpers) as shown in Figure 2-3, so that a positive signal will blank the display.

The HUM CANCELLING, HIGH VOLTAGE, and FOCUS controls are factory adjusted. Refer to the calibration section of this manual for adjustment of these controls.

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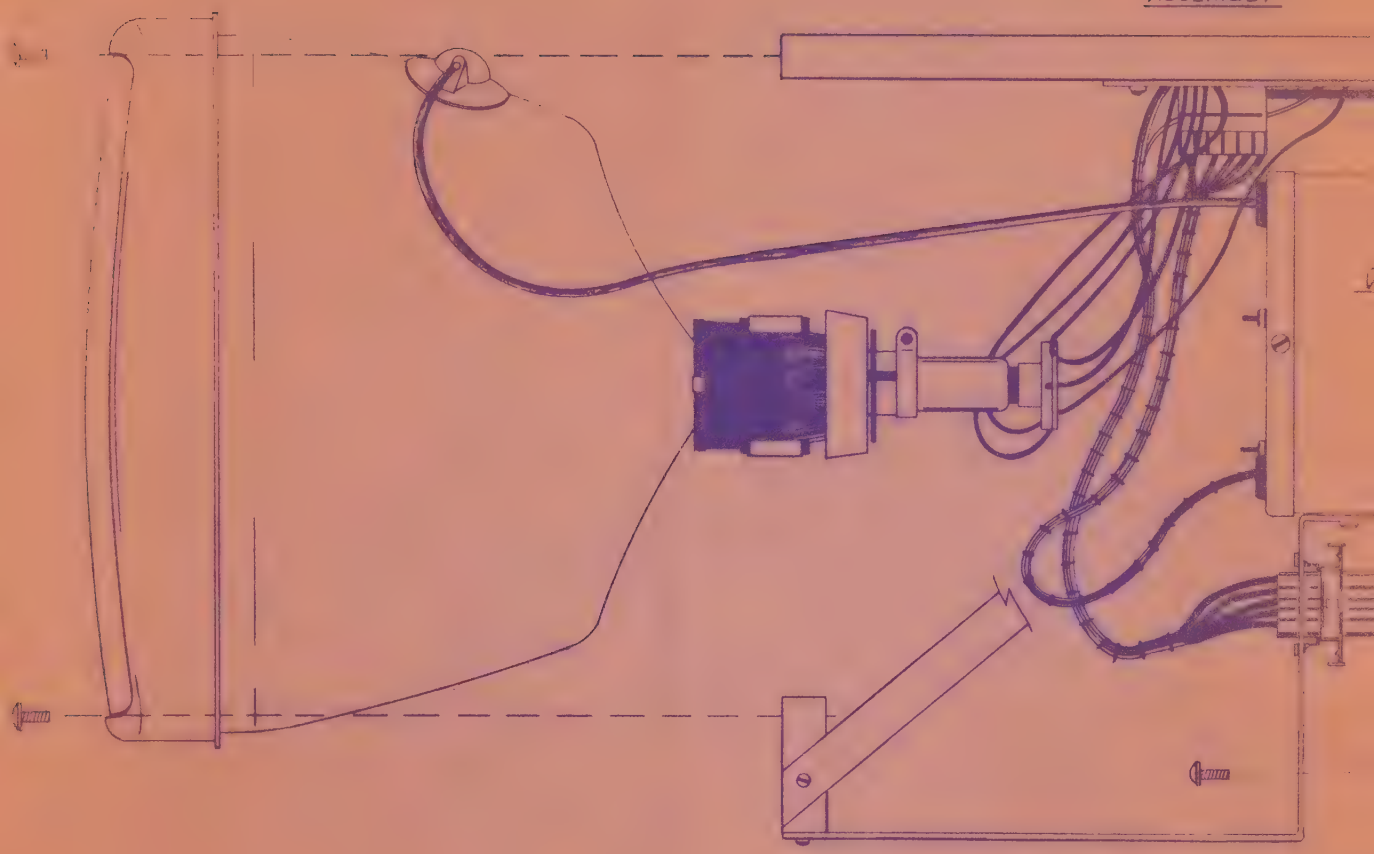
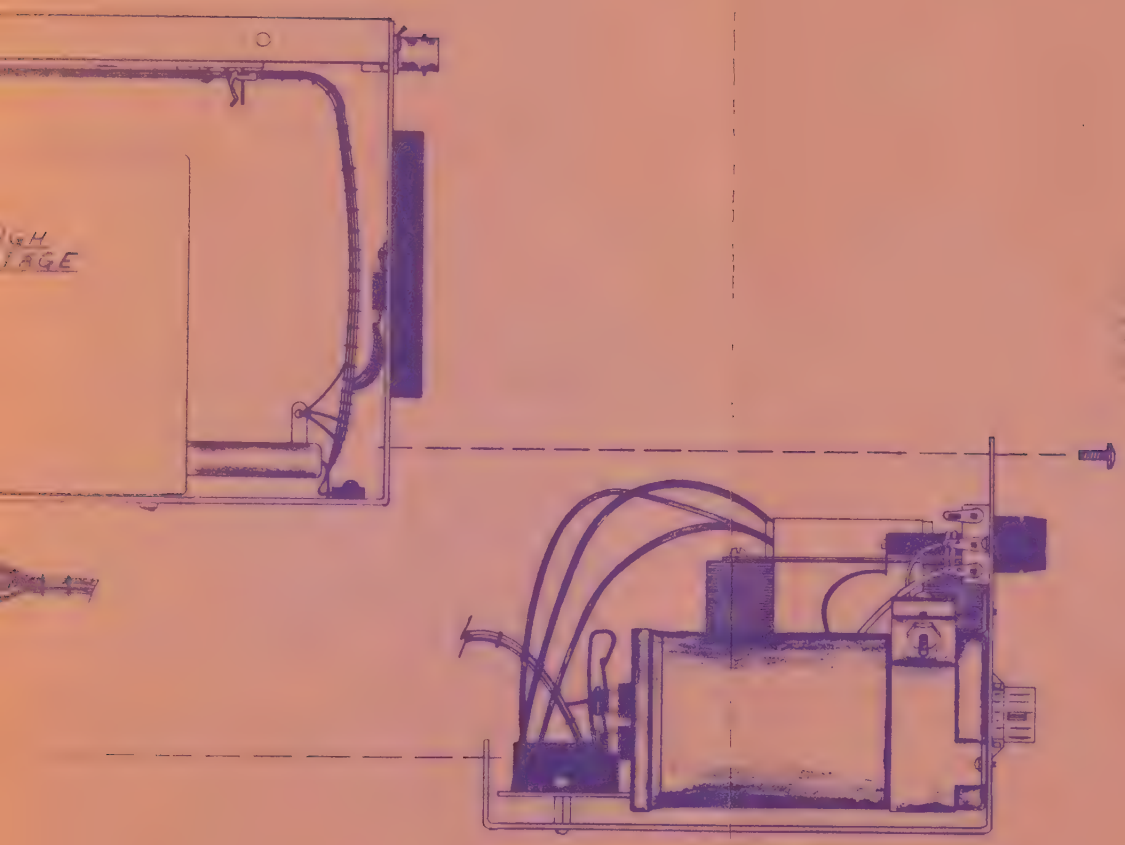
ASSEMBLY





LOW VOLTAGE POWER SUPPLY ASSEMBLY

Figure 2-2
Low Voltage
Supply Removal

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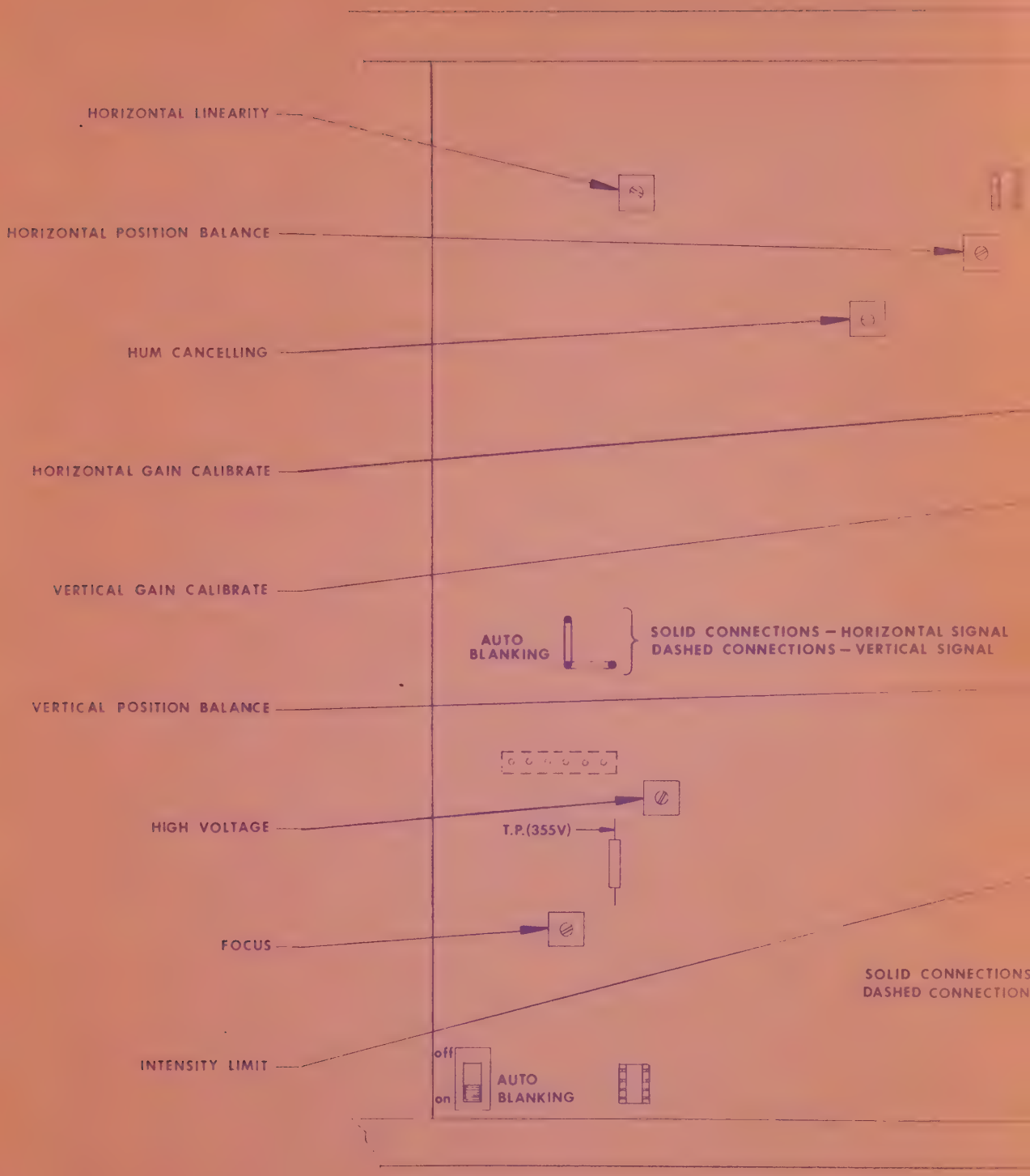

HORIZONTAL LINEARITY
HORIZONTAL POSITION BALANCE
HUM CANCELLING
HORIZONTAL GAIN CALIBRATE
VERTICAL GAIN CALIBRATE
AUTO BLANKING
SOLID CONNECTIONS – HORIZONTAL SIGNAL
DASHED CONNECTIONS – VERTICAL SIGNAL
VERTICAL POSITION BALANCE
HIGH VOLTAGE
T.P.(355V)
FOCUS
SOLID CONNECTIONS
DASHED CONNECTION
INTENSITY LIMIT
off
on
AUTO BLANKING

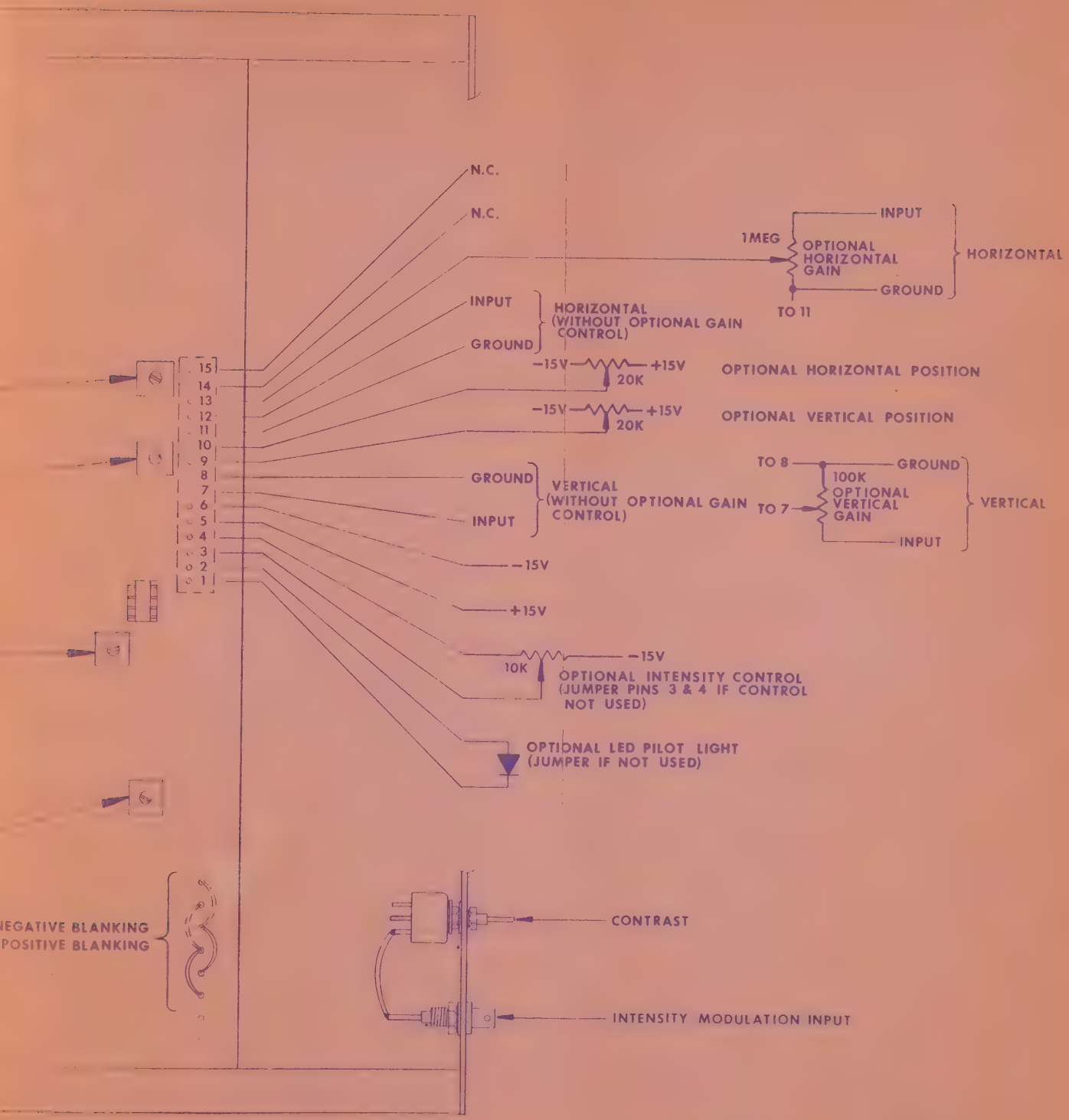


Figure 2-3
P.C. Board Controls And Connections

SECTION 3
CIRCUIT DESCRIPTION

3.1 INTRODUCTION

This section first presents an overall block diagram analysis followed by a more detailed description of each block.

3.2 SIMPLIFIED BLOCK DIAGRAM

The block diagram of Figure 3-1 shows the relationship of each main section to the total operation of the unit. The CRT (Cathode Ray Tube) is the heart of the display. The composite signal of all inputs to the unit is displayed on the face of the CRT.

The Power Supply and its associated regulators provide the unit with five voltage sources. The ±32 volt supplies are unregulated. The ±15.5 volt supplies are regulated, and the +68 volt supply is zener stabilized.

The High Voltage supply provides +9 kV to the anode of the CRT. The power source for this section is the +32 volt supply. The High Voltage supply also provides positive voltage for G2 and G4, (the focusing electrode), of the CRT.

The Vertical Amplifier converts the input-voltage signal into a currect signal for the vertical deflection yoke. The Vertical Amplifier has controls for adjusting the GAIN and POSITION of the vertical display on the CRT.

The Horizontal Amplifier converts the input-voltage signal to a corresponding current signal for the horizontal yoke on the CRT. The Horizontal Amplifier has controls for adjusting the GAIN and POSITION of the horizontal display on the CRT.

The CRT cathode is biased by the Z-Axis Amplifier. This amplifier includes the display INTENSITY control and the CONTRAST control which adjusts the amplitude of the intensity-modulation signal.

The Auto-Blanking circuit turns off the electron beam when horizontal deflection is small enough, or slow enough, to damage CRT phosphor.

3.3 POWER SUPPLY

The power transformer, rectifier diodes, and filter capacitors are located on the power supply chassis, while the regulator components are on the main printed-circuit board. The outputs are ±32 V unregulated DC, as well as ±15.5 V and +68 V regulated DC.

A dual-primary transformer, T401, allows for a line voltage of either 115 V or 230 VAC. The 50 V secondary is center tapped to allow for two full-wave rectified voltages. Unregulated +32 and -32 are filtered by C402 and C401 respectively. The +15.5 and -15.5 supplies are powered by the ±32 volt supplies. They are zener-diode regulated and have pass transistors for higher output current capability.

The source of the +68 V supply is derived from a voltage doubler stacked

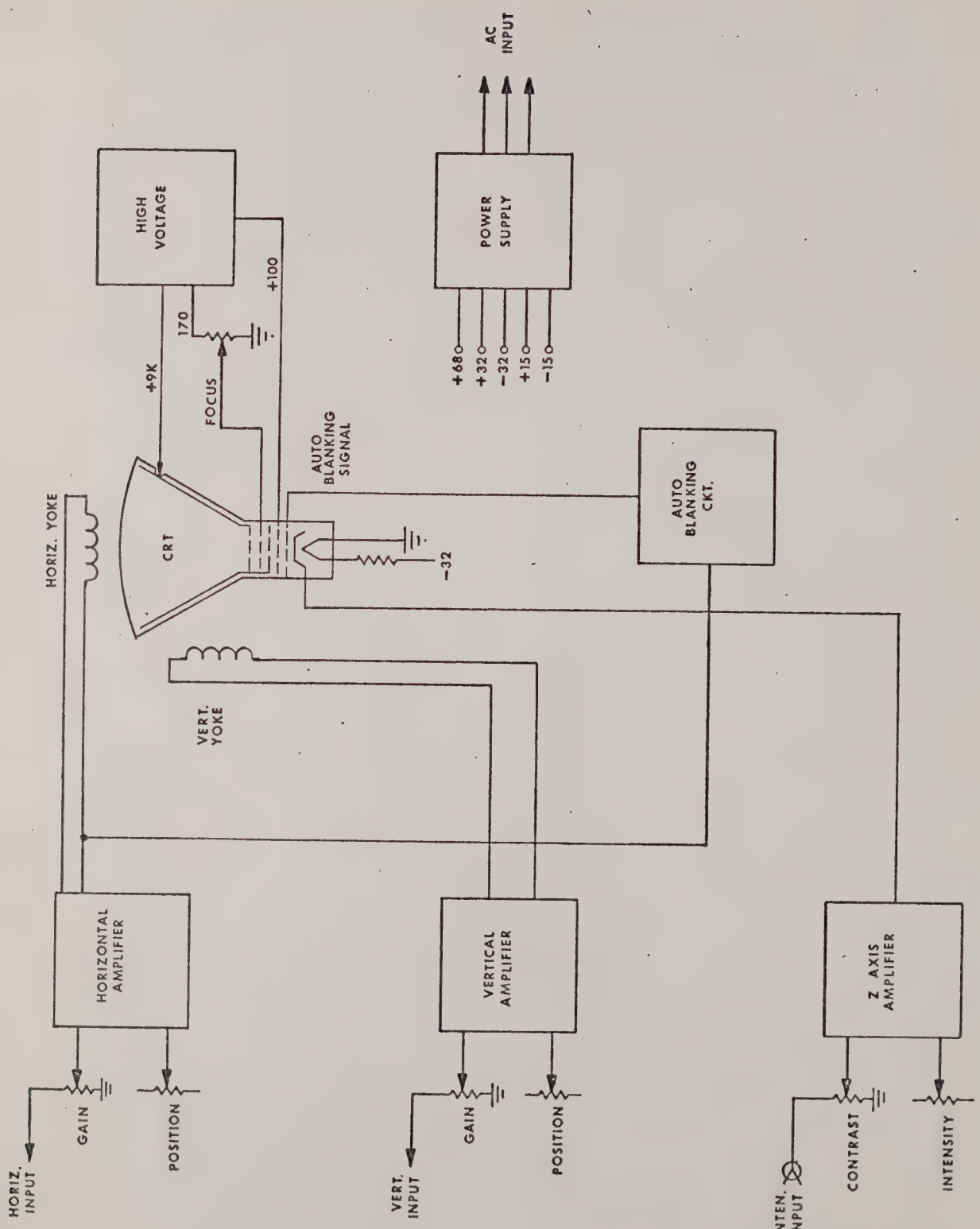


Figure 3-1. Simplified Block Diagram

on top of the +32 V supply. The 68 V supply is zener-diode regulated.

3.4 HIGH VOLTAGE SUPPLY

The high-voltage circuit is located away from the main printed-circuit board, and housed in a steel enclosure to prevent 20 kHz radiation. The high voltage circuit contains Q201, Q202 and Q203. It provides 9 kV to the CRT anode, as well as the voltage for the focusing electrode (G4), and +100 V for G2. Q203 is the heart of a ringing choke oscillator that develops a 20 kHz signal across T201. The oscillator signal is stepped up from 14 Vp to 2.25 kVp in the secondary of the transformer. It is then increased to +9 kV DC by the cascade quadrupler. The oscillator signal is stepped up to 355 Vp in the other secondary and rectified by CR202. The 355 volts is then fed to the focus control R105, (on the main board). The 100 volt supply is derived from a voltage divider on the 355 volt output.

Q201 and Q202 provide the supply voltage to the oscillator. This voltage is varied by a feedback signal in order to maintain a constant output level from the oscillator. The feedback is taken from R102 which is also the High Voltage adjustment. As the 9 kV supply is loaded, a bigger load is seen by the oscillator. This temporarily lowers the oscillator supply voltage, consequently coupling less voltage to the 355 V circuit. This results in a lower voltage at R102. This is inverted and amplified to provide a larger voltage supply to the oscillator, thus correcting for the additional loading.

3.5 VERTICAL AMPLIFIER

The Vertical Amplifier consists of IC1, Q1 through Q6, Q301, and Q302. The input signal is connected directly across GAIN pot R4, which feeds a selected fraction of the input signal to one-half of IC1. This op. amp. acts as an adder/buffer for the vertical-input signal and the DC balance signal from R1. The combined output is then routed to an inverting op. amp. IC1B. The other inputs to IC1B are the optional vertical-position signal, and the feedback signal voltage from R30 which is proportional to the current signal through vertical yoke L301A.

The output of IC1B drives a complementary symmetry, push-pull amplifier consisting of Q1, Q2, Q5, Q6, Q301, and Q302. This provides the high current gain necessary for driving vertical yoke L301A. Q3 and Q4 provide current limiting for Q301 and Q302, to prevent damage to the power transistors when the incoming signal is adequate to deflect display off the face of the CRT.

The vertical yoke L301A provides the magnetic field which deflects the electron beam up or down corresponding to changes in the vertical-input signal.

3.6 HORIZONTAL AMPLIFIER

The Horizontal Amplifier consists of IC2, Q9 through Q12, Q303, and Q304. The horizontal-input signal is fed directly to GAIN pot R42, which feeds a selected portion of the input signal to one-half of IC2, IC2A acts as an adder/buffer for the horizontal - input signal and the DC balance signal from R38. The combined output is then fed to IC2B, along with the optional horizontal-position signal, the feedback signal voltage from R64, and the Hum Cancelling voltage. The circuit consisting of R47, 48, CR21,22, 23, and 24 is designed to improve display linearity during the furthest excursion of the signal.

The output of IC2B drives another complementary symmetry, push - pull amplifier consisting of Q9, Q10, Q303, and Q304. This amplifier provides the high current gain necessary for driving horizontal yoke L301B. Q11 and Q12 are current limiters which prevent damage to Q303 and Q304 when the incoming signal is adequate to deflect display off the face of the CRT.

The horizontal yoke L301B provides the magnetic field for horizontal deflection of the electron beam.

3.7 AUTO BLANKING CIRCUIT

This circuit consists of IC3 and Q19. The input to IC3 is an alternating signal from the Horizontal Amplifier. This AC signal is amplified in IC3 and an average negative value is detected by CR29 and C11. Q19 is biased on by this signal. When the horizontal deflection is less than approximately 3 cm (60 Hz rate), the voltage on C11 is not sufficient to keep Q19 turned on. Turning Q19 off allows "G1" of the CRT to be biased with -32 volt supply through R94. This voltage will prevent electron flow to the CRT face thus preventing damage to the phosphor when there is no AC horizontal signal. This circuit can be overridden with S1 allowing extremely slow sweep rates to be displayed.

3.8 Z-AXIS AMPLIFIER

3.8.1 Intensity Control

The Display intensity is controlled by changing CRT cathode bias voltage; decreasing the positive voltage on the cathode increases brightness level. The cathode bias point is adjusted by Q17, Q25, and Q26, as determined by the setting of Intensity Limit R120 and the optional Intensity Control (if used).

3.8.2 Intensity Modulation

The Intensity - Modulation Amplifier consists of Q22, Q23, and Q24. The input signal is connected directly to CONTRAST control R302, which applies a selected portion of the signal to high-impedance buffer Q22. Q22 varies the bias applied to emitter follower Q24. Q23 is used in a temperature-compensation network to reduce variations in Q24's bias caused by temperature changes. Q24 then drives common-base (or common emitter, depending upon jumper configuration) Q25 to vary the CRT cathode bias point.

When Q25 is used in common-base configuration, a positive intensity-modulation signal will cause the trace to brighten (neg. blanking); while a common-emitter connection for Q25 results in pos. blanking (a negative intensity input brightens trace).

3.9 CATHODE RAY TUBE

The CRT is a 12" rectangular tube using magnetic deflection, and has the following specifications: P1 phosphor, standard (other phosphors available as options); electrostatic focusing (G4); 90° diagonal deflection; and 12.6 V heater voltage.

The screen is supplied with +9 kV by the High Voltage circuit.

SECTION 4
MAINTENANCE

4.1 INTRODUCTION

This section provides information for performance testing, calibration and troubleshooting the Wavetek Display. The performance test is designed for incoming inspection and periodic evaluation. If performance is not to specifications, refer to the calibration and troubleshooting sections.

4.2 SERVICE INFORMATION

To remove the high voltage circuit from its metal box, there is one horizontal screw on each side of the lid which must be removed. DO NOT remove screws or nuts on top of lid. The circuitry is mounted on the lid and will be removed from the box when the lid is lifted straight up.

4.2.1 Transistor and IC Lead Configurations

Due to the many variations in lead configurations, Figure 4-1 shows the lead arrangement for the transistors and IC's used in this unit.

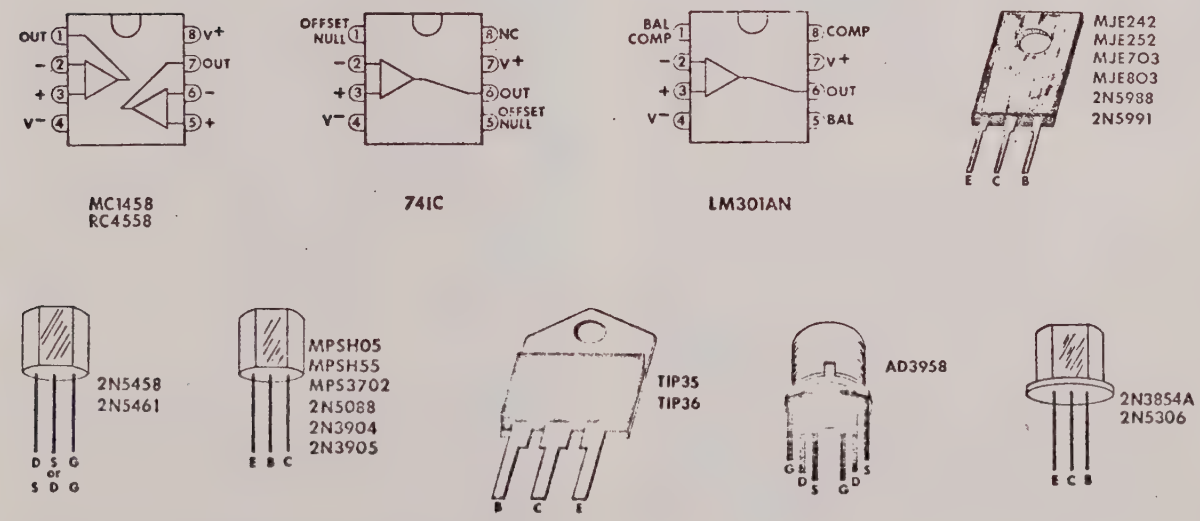


Figure 4-1. Lead Configurations

TABLE 4-1. RECOMMENDED TEST EQUIPMENT

INSTRUMENT	CRITICAL REQUIREMENTS	RECOMMENDED
Oscilloscope	Lab grade, D.C. coupled with Low Cap. Probe	Tektronix 5403 with 5A48 Vertical Amp 5B42 Time Base
Voltmeter	10 Megohm input impedance	Weston Model 4440
Function Generator	2 independent frequency outputs	Wavetek Model 144
HV Meter	300 Megohm input impedance	Pomona Model 3157 High voltage test probe.

4.3 PERFORMANCE CHECKS

The following procedure is intended to insure that the instrument meets its published specifications. Recommended test equipment is given in Table 4-1.

The instrument controls should be set as follows: POWER off, INTENSITY minimum (fully ccw), HORIZONTAL and VERTICAL BALANCE controls to mid position, HORIZONTAL GAIN fully cw, VERTICAL GAIN fully clockwise. The main board AUTO BLANKING switch should be in the ON position.

Switch the POWER on and allow a 5 minute warmup before proceeding.

4.3.1 Vertical Position Control Check

Apply an AC signal to the Horizontal input. Approximately 2 volts peak-to peak will extend the full width of the scope face with GAIN set at maximum. If the Auto Blanking circuit is excited by the Vertical amp., switch AUTO BLANKING switch on main board to its OFF position.

CAUTION: Do NOT turn AUTO BLANKING off without a signal to the scope Horizontal input. The result would be a bright dot which would burn the CRT phosphor.

Turn INTENSITY up until trace appears. Then, turning the Vertical BALANCE control should position line off the screen in both directions. Return BALANCE control to mid position to center the line. Place the AUTO BLANKING switch to its ON position.

4.3.2 Horizontal Position Control Check

Apply an AC signal to the Vertical input. Approximately 2 volts peak-to peak will extend the full height of the scope face with GAIN control set at maximum. If the Auto Blanking circuit is excited by the Horizontal amp., place AUTO BLANKING switch in the OFF position.

CAUTION: To prevent burning the CRT phosphor, do NOT turn AUTO BLANKING off without a signal to the scope Vertical input.

Turning the Horizontal BALANCE control should position line off the screen in either direction. Return BALANCE control to mid position to center the line. Turn ON the AUTO BLANKING switch.

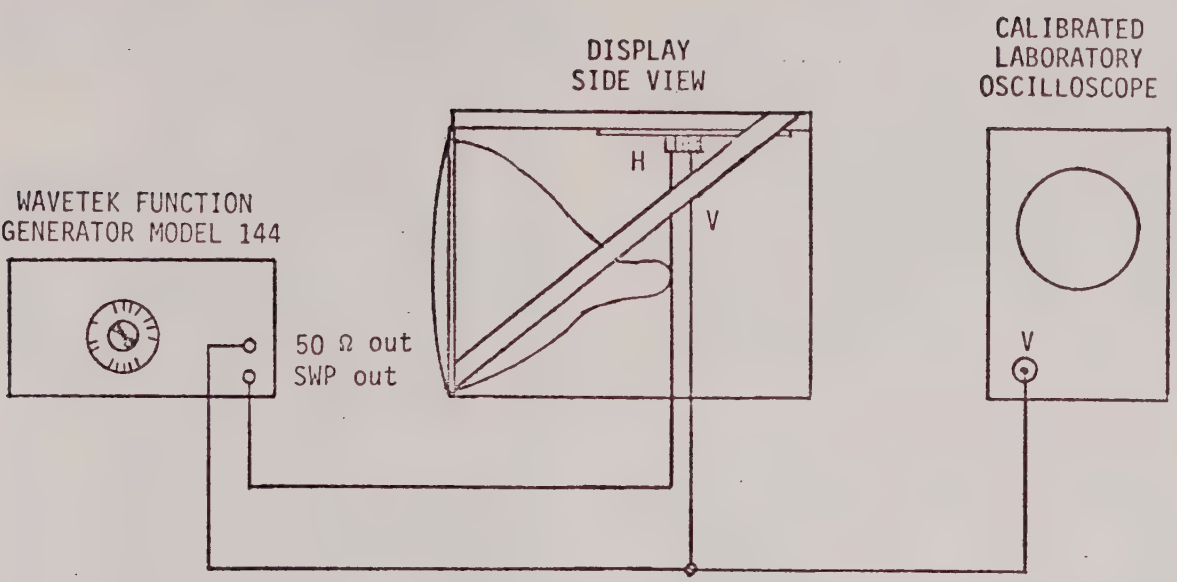


Figure 4-2. Vertical Gain Setup

4.3.3 Vertical Gain Check

Connect the Display as shown in Figure 4-2. Turn Vertical GAIN to maximum. Set function generator frequency to 1 kHz. Set sweep output for approximately 10 milliseconds (or set a second generator for 100 Hz). Set amplitude to 18 cm deflection on Display vertical axis. Adjust Horizontal GAIN and Vertical and Horizontal BALANCE controls for a pattern similar to Figure 4-3. The function generator output, according to the lab scope, should be less than 1.5 V p-p.

Figure 4-3. Vertical Gain Check

4.3.4 Vertical Bandwidth Check

Maintaining previous hookup, set Vertical frequency for 1 kHz at 15 cm. Increase the frequency of the function generator to 15 kHz. The Display amplitude should be at least 10.5 cm in amplitude (3 dB point).

4.3.5 Vertical Linearity Check

Reduce the frequency of the function generator to 1 kHz. Turn off the Auto Blanking (if excited by Vertical amp.). Reduce amplitude of the signal from the function generator to 1.5 cm on the scope face. This 1.5 cm reference should be set up on the center of the Display. Using the Vertical BALANCE control, move the trace up and down. Its amplitude should not vary more than 5%. TURN ON THE AUTO BLANKING.

4.3.6 Horizontal Gain Check

Reduce frequency of the function generator to 100 Hz. Reverse the Horizontal and Vertical connections to the Display. Adjust Horizontal and Vertical controls on the Display to produce a pattern similar to Figure 4-4. Turn the Horizontal GAIN control to maximum, and adjust the function generator output for 24 cm deflection. Measure this amplitude using the calibrated scope in the test setup. The function generator output must be less than 1.8 V p-p.

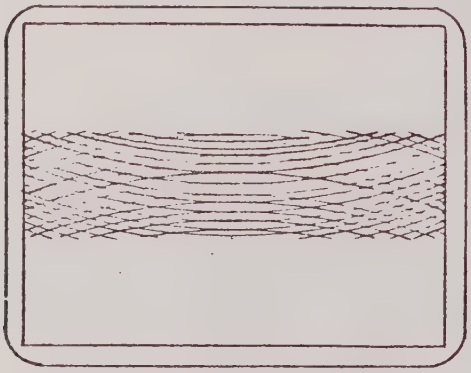


Figure 4-4. Horizontal Gain Check

4.3.7 Horizontal Bandwidth Check

Using output control on the function generator and the Horizontal GAIN control on the Display, adjust the pattern until it is 21 cm wide. Increase frequency of the function generator to 1.5 kHz. The Display amplitude should be at least 14.7 cm wide (3 dB point).

4.3.8 Horizontal Linearity Check

Reduce frequency of the function generator to 100 Hz. Turn off the Auto Blanking (if excited by Horizontal amp.). Adjust amplitude of the signal from the function generator until the horizontal display is 1.5 cm wide in the center of the scope face. Using the Horizontal BALANCE control, move the displayed pattern from left to right over the center 24 cm. Its amplitude should not vary more than 3%. TURN ON THE AUTO BLANKING.

4.3.9 Vertical Polarity Check

Apply an AC signal to scope Horizontal input, in order to produce a Horizontal line. Temporarily switch off the Auto Blanking (if excited by Vertical amp.). Apply a positive DC voltage to the Display Vertical input. The line should move to the upper half of the scope face. TURN ON THE AUTO BLANKING.

NOTE: If the Vertical polarity has been internally reversed, a positive DC voltage will cause the line to move to the lower half of the scope face.

4.3.10 Horizontal Polarity Check

Apply an AC signal to scope Vertical input, to produce a Vertical line. Temporarily switch off the Auto Blanking (if excited by Horizontal amp.). Apply a positive DC voltage to the Display Horizontal input. The line should move to the right half of the scope face. TURN ON THE AUTO BLANKING.

NOTE: If the Horizontal polarity has been internally reversed, a positive DC voltage will cause the line to move to the left half of the scope face.

4.3.11 Z-Axis Gain Check

Feed 100 kHz from the function generator into Intensity input. Turn CONTRAST control to max. Monitor CRT cathode voltage using Lab Scope with a low-capacity probe. Adjust function generator output for 18 V p-p (at cathode). Move probe to input. The input signal should be less than 1 V p-p. Return the probe to the cathode.

4.3.12 Z-Axis Bandwidth

Using the previous setup, vary the function generator frequency to 1 MHz, 3

MHz and 10 MHz. The output should be no less than 1 dB, 3dB and 10 dB down respectively.

4.4 CALIBRATION PROCEDURE

In general, calibration must be performed in the sequence given.

Before turning POWER on, turn INTENSITY fully counterclockwise. Plug line cord into autotransformer set at exactly 115 volts. Turn POWER on and allow a 5 minute warmup period before calibrating.

4.4.1 Power Supply Checks

With lab grade oscilloscope, check ±32 V. With Vertical POSITION BAL control fully clockwise, the +32 V should be +33 volts ±.5 V, the -32 V supply should be -31 V with ±1 V ripple. With the Vertical POSITION BAL control fully counterclockwise, the +32 supply should be +31 V ±1 V ripple, the -32 supply should be -33 V ±.5 V.
With the voltmeter, check + and -15.5 V supplies. These should be within 5% of nominal value. Check +68 V, this should be within 10% of nominal value.

4.4.2 High Voltage Adjustment

With high impedance (10 Megohm) meter and trace cut off, set +355 volt supply at T.P. with High Voltage pot on printed circuit board. Check +9 kV ±500 V by sliding probe under High Voltage connector cover on CRT anode.

4.4.3 Yoke Adjustment

Apply an AC signal to the Horizontal input only. Turn the INTENSITY down, switch off the Auto Blanking; then, turn up INTENSITY for a visible trace. Adjust Horizontal GAIN and BALANCE controls for a full screen Horizontal line. Rotate the Yoke for a line with no Horizontal tilt. Adjust the centering rings for least bowing. TURN ON THE AUTO BLANKING.

4.4.4 Horizontal Linearity Adjustment

Apply AC signals to the Horizontal and Vertical inputs. Switch off the Auto Blanking, and turn up INTENSITY control until the trace is visible. Adjust Horizontal BALANCE and GAIN controls for a centered 9 cm Horizontal display. Using the Horizontal BALANCE control, move the trace to right-hand side of the screen. Adjust Horizontal Linearity control for a 9 cm deflection. TURN ON AUTO BLANKING.

4.4.5 Horizontal Bal and Gain Adjust

The Horizontal BALANCE control is adjusted to center trace when the external Horizontal position control is set to the center of its range. The Horizontal GAIN calibrate is set to maximum cw when an external gain control is used. If no external controls are used, the Horizontal GAIN calibration and BALANCE controls function as gain and position controls.

4.4.6 Vertical Bal and Gain Adjust

The Vertical BALANCE control is adjusted to center trace when the external Vertical position control is set to the center of its range. The Vertical GAIN calibrate is set for the desired maximum range of the external gain control. If no external controls are used, the Vertical GAIN calibration and BALANCE controls function as gain and position controls.

4.4.7 Intensity Limit and Contrast Adjustment

The CONTRAST control varies the sensitivity of the intensity modulation, and is adjusted for the desired contrast when Z-axis modulation is used. The INTENSITY LIMIT control is adjusted to set the maximum range of an external intensity control. With no external control, the INTENSITY LIMIT functions as an intensity control.

LABORATORIES II

4.4.8 Hum Cancelling Adjustment

Apply an AC signal to the Vertical input only, and switch off the Auto Blanking. Adjust HUM CANCELLING control for minimum Horizontal deflection of the vertical line on scope face. TURN ON AUTO BLANKING.

4.5 TROUBLESHOOTING

Troubleshooting is generally a systematic procedure of "divide and conquer". A thorough understanding of the block diagram and circuit description located in Section 3, and the calibration procedure located in Section 4.4 of this manual, will enable the trouble symptom to be associated with a particular circuit or component.

Equipment troubles are frequently due simply to improper control settings. Refer to the operating instructions in Section 2 for an explanation of each control's function along with typical operating instructions. If in doubt, also use the controls to help isolate a trouble to a specific area of the instrument.

After verifying that trouble is not improper setting of the controls or test setup, make a thorough check of the instrument's performance by following the calibration procedure in Section 4.4. By following the calibration procedure, a trouble can be localized to a specific circuit or component. After localizing a trouble to a specific area of the unit, make a good visual check of the area. Check for burned or broken components.

SECTION 5

SCHEMATICS AND PARTS LISTS

5.1 INTRODUCTION - This section contains all schematics and a list of replaceable parts for the instrument. In an assembly containing one or more subassemblies, the assembly parts list is divided to separate the subassemblies. The subassembly three-digit circuit reference on the schematic is represented in the REFERENCE SYMBOL column by the last one or two digits. The first digit represents the subassembly on which the part is located. The subassembly (100, 200 . . .) is indicated next to the reference symbol heading. Also included are the Wavetek code for component manufacturer, an explanation of schematic symbols, and a list of abbreviations used in the text.

5.2 MANUFACTURER'S CODE - The following code is used on the parts list to identify the manufacturer.

A-B	Allen-Bradley	Milwaukee, Wisconsin
ACI	Advance Components, Inc.	Centerbrook, Connecticut
A-D	Analog Devices	Norwood, Massachusetts
AER	AVX	Myrtle Beach, South Carolina
A-I	Alan Industries	Columbus, Indiana
AIN	Alpha Industries, Inc.	Woburn, Massachusetts
ALC	Alco Electronics Products, Inc.	Lawrence, Massachusetts
AMP	AMP, Inc.	Harrisburg, Pennsylvania
APL	Amphenol	Danbury, Connecticut
A-P	American Plasticraft (APCO)	Chicago, Illinois
APX	Amperex	Slatersville, Rhode Island
ARC	ARCO Electronics	Great Neck, New York
ASE	Airco Speer Electronics	Nogales, Arizona
AVT	Avantek	Santa Clara, California
BEK	Beckman Instruments, Inc.	Fullerton, California
BEL	Belden	Chicago, Illinois
BER	Berg Electronics	New Cumberland, Pennsylvania
BOU	Bourns	Riverside, California
BUS	Bussman	St. Louis, Missouri
CAM	Cambion	Cambridge, Massachusetts
CAR	Carling Electric, Inc.	West Hartford, Connecticut
C-D	Cornell Dubilier	Newark, New Jersey
C-E	Clinton Electronics	Rockford, Illinois
CGW	Corning Glass Works	Corning, New York
CHE	Cherry Electrical Products, Prod.	Waukegan, Illinois
C-H	Cutler-Hammer	Milwaukee, Wisconsin
C-I	Components Incorporated	Biddeford, Maine
C-J	Cinch Jones	Elk Grove Village, Illinois
C-K	C & K Components	Watertown, Massachusetts
CKI	CTS Knight, Inc.	Sandwich, Illinois
C-L	Centralab	Milwaukee, Wisconsin
CLA	Clairex Electronics	Mount Vernon, New York
CTS	Chicago Telephone Systems	Elkhart, Indiana
C-W	C-W Industries	Philadelphia, Pennsylvania
DAL	Dale Technology Corp.	Hartsdale, New York
DEL	Delevan	East Aurora, New York
DIO	Diodes, Inc.	Chatsworth, California
DRA	Drake Mfg. Company	Harwood Heights, Illinois
ETP	Erie Technological Prod., Inc.	Erie, Pennsylvania
FCD	Fairchild	Mountain View, California

C-E	General Electric	Syracuse, New York
C-H	Grayhill	La Grange, Illinois
C-I	General Instrument Semi., Comp.	Hicksville, New York
HEL	Helipot	Anaheim, California
HEY	Heyman Mfg. Company	Kenilworth, New Jersey
HHS	Herman H. Smith, Inc.	Brooklyn, New York
HIT	Hitachi America Ltd.	Chicago, Illinois
H-P	Hewlett-Packard	Palo Alto, California
INT	Intersil, Inc.	St. Palos Heights, Illinois
IRC	International Resistance Co.	Philadelphia, Pennsylvania
ITT	International Telephone and Telegraph	West Palm Beach, Florida
JEF	Jeffers	Dubois, Pennsylvania
JEW	Jewell Electrical Instruments	Manchester, New Hampshire
JON	E.F. Johnson Company	Waseca, Minnesota
KEM	Kemtron Electron Products, Inc.	Newburyport, Massachusetts
KID	Kidco, Inc.	Medford, New Jersey
KIN	Kings	Tuckahoe, New York
KSW	KSW Electronics	Burlington, Massachusetts
LIT	Littelfuse	Des Plaines, Illinois
M-A	Microwave Associates	Burlington, Massachusetts
MAL	Mallory	Indianapolis, Indiana
MDC	Maida Development Co.	Hampton, Virginia
M-E	Mepco/Electra	Mineral Wells, Texas
M-O	Marko-Oak	Anaheim, California
MOL	Molex	Downers Grove, Illinois
MOT	Motorola	Phoenix, Arizona
NAT	National Semiconductor Corp.	Santa Clara, California
NEC	Nippon Electric Company, Limited	Burlingame, California
N-T	National Teltronics	Laredo, Texas
OHM	Ohmite Mfg. Company	Skokie, Illinois
O-S	Omni Spectra, Inc.	Farmington, Michigan
P-B	Potter and Brumfield	Princeton, Indiana
POM	Pomona Electronics Co., Inc.	Pomona, California
Q-C	Quality Components	St. Marys, Pennsylvania
RAY	Raytheon	Burlington, Massachusetts
RCA	RCA	Harrison, New Jersey
RMC	Radio Material Company	Chicago, Illinois
S-C	Specialty Connector	Indianapolis, Indiana
SCC	Stackpole Carbon Co.	St. Marys, Pennsylvania
SEL	Sealectro	Mamaroneck, New York
SEM	Semtech	Newbury Park, California
S-G	Standard Grigsby	Aurora, Illinois
SGM	Sigma	Braintree, Massachusetts
S-I	Switchcraft, Inc.	Chicago, Illinois
SIG	Signetics Corporation	Sunnyvale, California
SPE	Spetrol	City of Industry, California
SPR	Sprague	North Adams, Massachusetts
SSS	Solid State Scientific	Montgomeryville, Pennsylvania
S-T	Sarkes Tarzian	Bloomington, Indiana
STR	Stettner Trush	Cazenovia, New York
SYL	Sylvania	Woburn, Massachusetts
SYS	Syscon International	South Bend, Indiana
THR	Thermalloy, Co.	Dallas, Texas
T-I	Texas Instruments	Dallas, Texas
TRW	TRW Capacitor Division	Ogallala, Nebraska
VAC	VACTEC	Maryland Heights, Missouri
VAR	Varadyne Capacitor Div.	Santa Monica, California
W-E	Wells Electronics	South Bend, Indiana
W-I	Wavetek Indiana, Inc.	Beech Grove, Indiana
WSD	Wavetek, San Diego	San Diego, California
WSR	Wavetek, Santa Rosa	Santa Rosa, California

5.3 SCHEMATIC NOTES - The following notes and abbreviations pertain to all schematics. Additional notes pertaining to specific schematics are included on each schematic if required.

All resistor values are shown in ohms unless otherwise specified.
All capacitor values are shown in picofarads (pF) unless otherwise specified.
All inductor values are shown in microhenries (μH) unless otherwise specified.

Denotes DC voltage reading in volts unless otherwise specified.

Denotes high impedance crystal detector reading in volts unless otherwise specified.

Denotes 50 ohm crystal detector reading in volts unless otherwise specified.

Signal or voltage source.

Connects to indicated signal or voltage source.

Arrow indicates clockwise rotation of wiper.

Coaxial jack

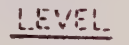
Coaxial plug

Coaxial cable

Factory adjusted part.

Denotes a front-panel device.

Denotes a rear-panel device.



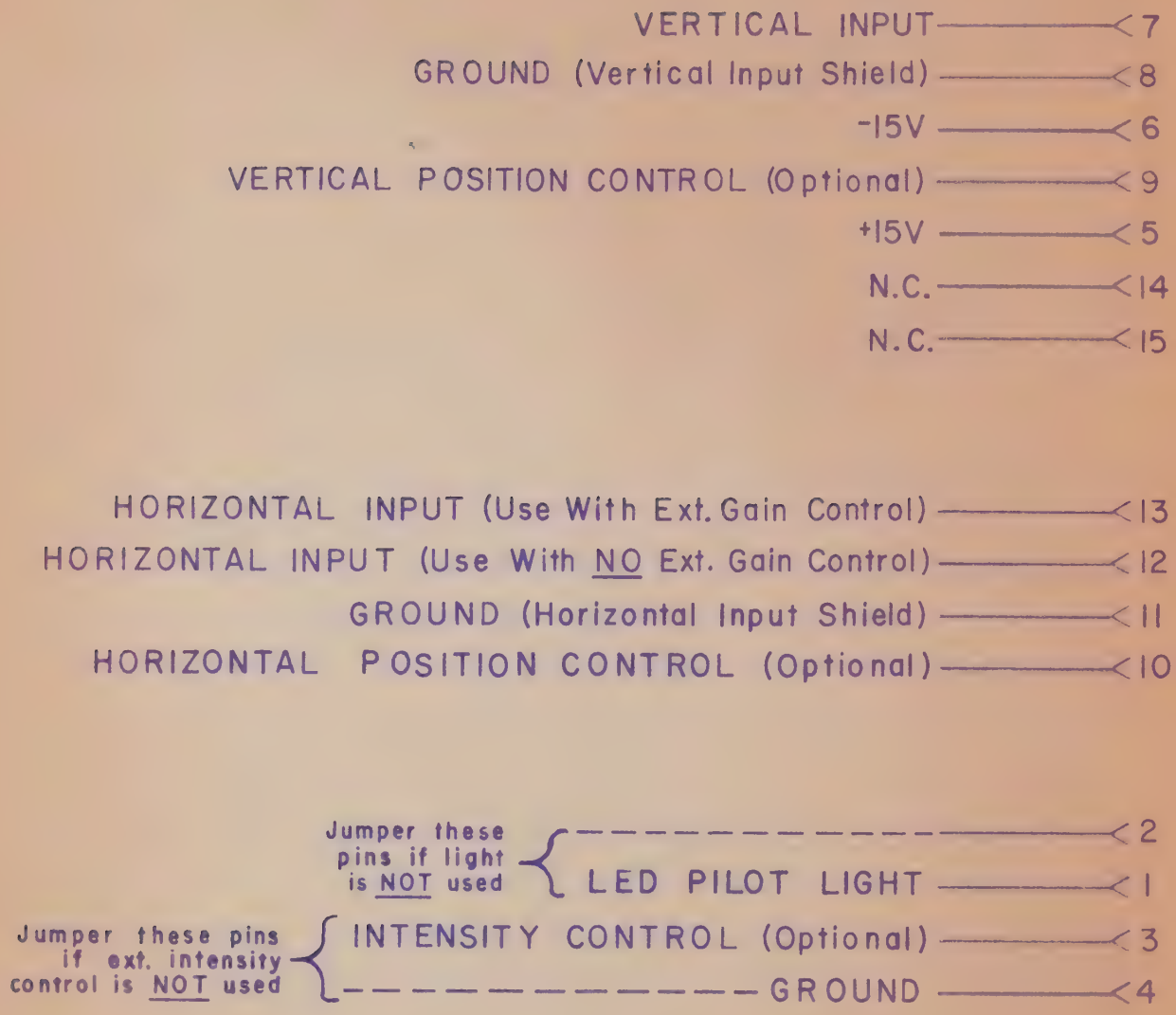
Denotes a PC board adjustment or accessible module adjustment.

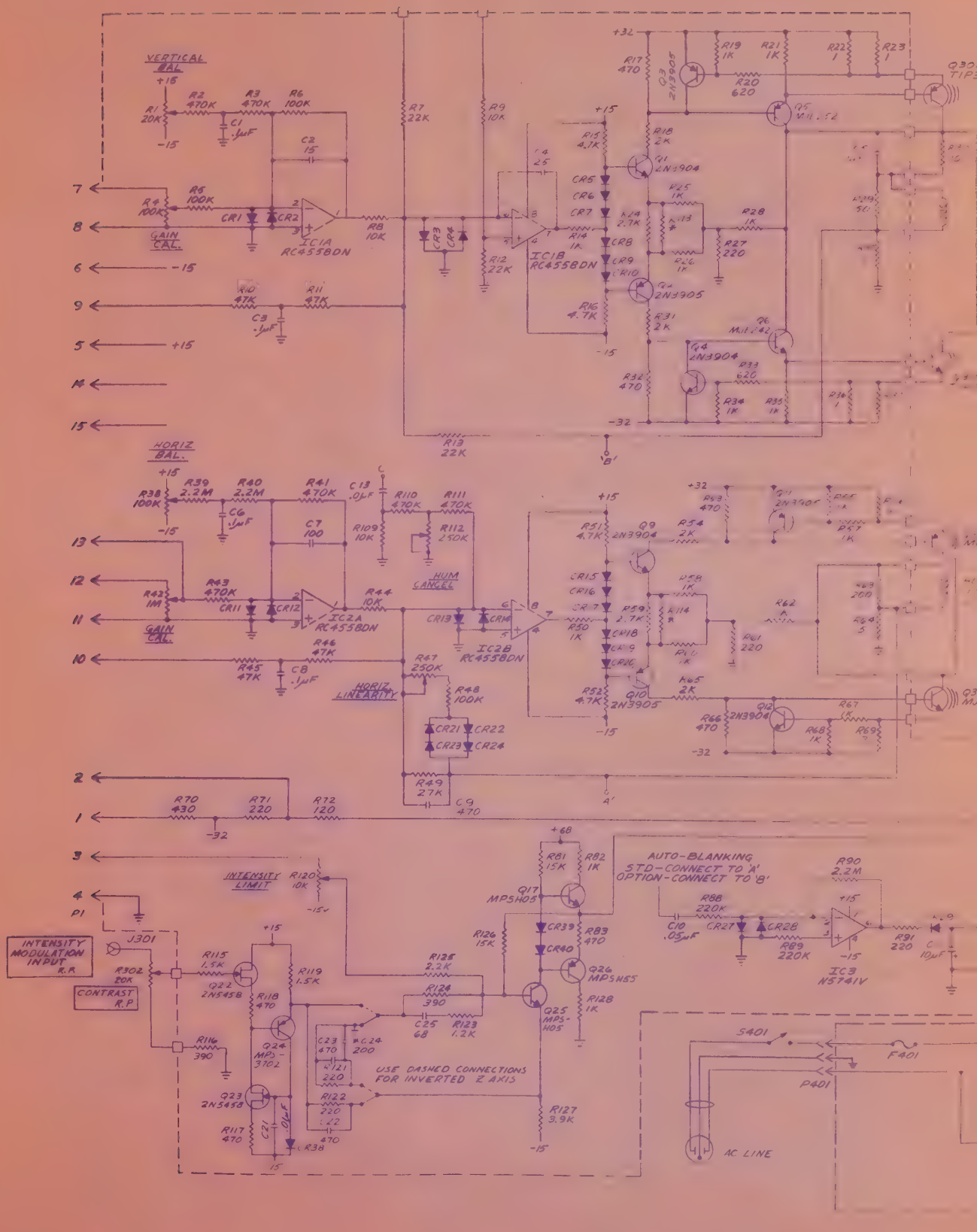
Denotes an internal module adjustment not accessible without removing module cover.

5.4 ABBREVIATION CODE

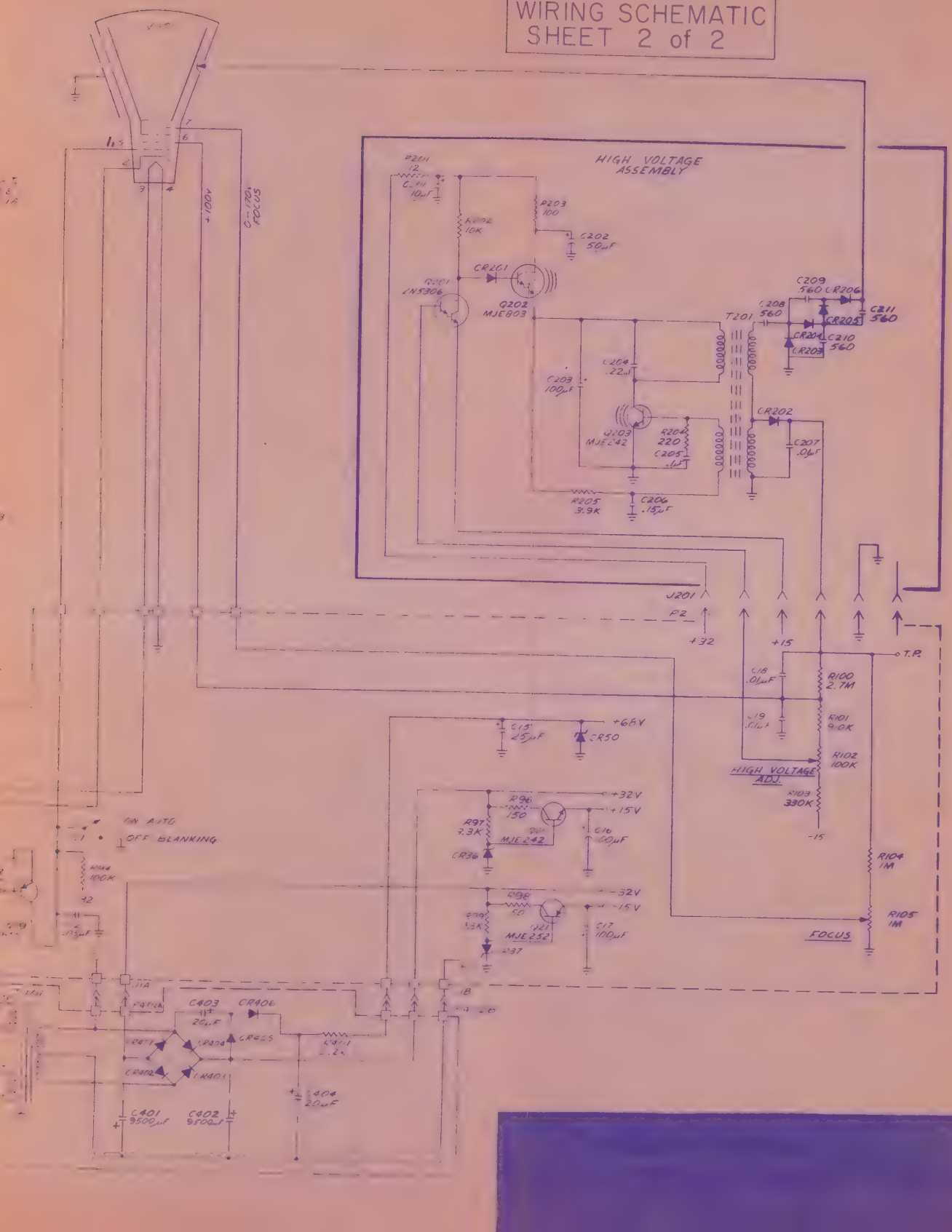
A	ampere	K	relay	Ω	ohm
AC	alternating current	kHz	kilohertz	P	plug
C	capacitor	kΩ	kilohm	pp	peak-to-peak
CR	diode	kV	kilovolt	pF	picofarad
dB	decibel	kW	kilowatt	Q	transistor
dBm	decibel referred to 1 mW	L	inductor	R	resistor
dBmV	decibel referred to 1 mV	MHz	megahertz	RF	radio frequency
DC	direct current	MΩ	megohm	RMS	root-mean-square
DS	indicating device, lamp	μF	microfarad	R.P.	rear panel
F	farad	μA	microampere	S	switch
F.P.	front panel	μH	microhenry	T	transformer
H	henry	M	meter	TP	test point
Har	harmonic	mA	milliampere	V	volt
Hz	hertz	mH	millihenry	VA	voltampere
IC	integrated circuit	mV	millivolt	W	watt
IF	intermediate frequency	mW	milliwatt	X	crystal
J	jack				

MODEL 1951
WIRING SCHEMATIC
SHEET 1 of 2


VERTICAL INPUT 7
GROUND (Vertical Input Shield) 8
-15V 6
VERTICAL POSITION CONTROL (Optional) 9
+15V 5
N.C. 14
N.C. 15
HORIZONTAL INPUT (Use With Ext. Gain Control) 13
HORIZONTAL INPUT (Use With NO Ext. Gain Control) 12
GROUND (Horizontal Input Shield) 11
HORIZONTAL POSITION CONTROL (Optional) 10
Jumper these pins if light is NOT used
2
LED PILOT LIGHT 1
Jumper these pins if ext. intensity control is NOT used
INTENSITY CONTROL (Optional) 3
GROUND 4


VERTICAL BAL
HORIZ BAL.
GAIN CAL.
HUM CANCEL
HORIZ LINEARITY
INTENSITY LIMIT
INTENSITY MODULATION INPUT R.R
CONTRAST R.P
AUTO-BLANKING
STD-CONNECT TO 'A'
OPTION-CONNECT TO 'B'
USE DASHED CONNECTIONS FOR INVERTED Z AXIS
IC1A RC4558DN
IC1B RC4558DN
IC2A RC4558DN
IC2B RC4558DN
IC3 N5741V
AC LINE
S401
F401
P401
J301

MODEL 1951
WIRING SCHEMATIC
SHEET 2 of 2



PARTS LIST

MODEL 1951 Main Board

REV A

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"C"	CAPACITORS				
1,3,6,8	Cer Disc, .1 µF 100 V	CD103-410	SPR	TG-P10	4
2	Cer Disc, 15 pF	CD101-015	SPR	10TCC-Q15	1
4	Cer Disc, 25 pF	CD101-025	SPR	10TCC-Q25	1
5	Mylar, 1 µF	CP103-510	SPR	225P	1
7	Cer Disc, 100 pF	CD104-110	SPR	10TCU-T10	1
9,22,23	Cer Disc, 470 pF	CD102-147	SPR	5GA-T47	3
10,12	Cer Disc, .05 µF +80 -20% 100 V	CD103-350	SPR	TG-S50	2
11	Elect, 10 µF 25 V	CE105-010	SPR	TE1204	1
15	Elect, 25 µF 100 V	CE121-025	MAL	TT100X25	1
16,17	Elect, 100 µF 25 V	CE105-110	SPR	TE1211	2
18,19,21	Cer Disc, .01 µF 1 kV	CD102-310	SPR	5GA-S10	3
24	Cer Disc, 200 pF*	CD104-120	SPR	10TCU-T20	1
25	Cer Disc, 68 pF	CD104-068	SPR	10TCU-Q68	1
"CR"	DIODES				
1 thru 20, 27,28,38, 39,40	Si, Computer Diode	DG109-140	G-E	1N914	25
21,22,23, 24,29	Si, Junction 400 PIV 3/4 amp	DR000-001	DIO	1N4004	5
36, 37	Zener, 16 V ±5%, 1 W	DB000-012	MOT	1N4745	2
50	Zener, 68 V ±10%, 1 W	DB000-004	C-L	ZD68A	1
"IC"	INTEGRATED CIRCUITS				
1,2	Dual Op. Amp. RC4558DN RAY only	IC000-027	W-I	IC000-027	2
3	Operational Amplifier	IC000-002	SIG	N5741V	1
"P"	CONNECTORS (PLUGS)				
1	15 pin Locking Plug	MC000-080	MOL	09-65-1151	1
2	6 pin Locking Plug	MC000-075	MOL	09-65-1061	1
"J"	CONNECTORS (JACKS)				
1	5 pin Socket	MC000-087	MOL	03-06-1055	1
	Contacts, Female	MC000-018	MOL	1855	1
	Contacts, Female	MC000-042	MOL	1561	4
"Q"	TRANSISTORS				
1,4,9,12	NPN, Si	QA039-040	NAT	2N3904	4
2,3,10,11	PNP, Si	QA039-050	NAT	2N3905	4
5,21	PNP, Si, Power	QB000-022	MOT	MJE252	2
6,20	NPN, Si, Power	QB000-023	MOT	MJE242	2
17,25	NPN, Si	QB000-032	MOT	MPSH05	2
19,26	PNP, Si	QB000-027	MOT	MPSH55	2
22,23	N-channel, JFET, matched pair	QB000-007	W-I	QB000-007	1
24	PNP, Si	QB000-009	MOT	MPS3702	1

PARTS LIST

MODEL 1951 Main Board

REV A

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"R "	RESISTORS				
1	Var Cermet, 20 kΩ	RP131-320	CTS	360T203	1
2,3,41,110, 111	Comp, 470 kΩ ±10%,¼ W	RC104-447	A-B	CB4741	5
4,38,102	Var Cermet, 100 kΩ	RP131-410	CTS	360T104	3
5,6,48,94	Comp, 100 kΩ ±10%,¼ W	RC104-410	A-B	CB1041	4
7,12,13	Comp, 22 kΩ ±10%,¼ W	RC104-322	A-B	CB2231	3
8,9,44,92, 93,109	Comp, 10 kΩ ±10%,¼ W	RC104-310	A-B	CB1031	6
10,11,45,46	Comp, 47 kΩ ±10%,¼ W	RC104-347	A-B	CB4731	4
14,21,35,50, 82,128	Comp, 1 kΩ ±10%,¼ W	RC104-210	A-B	CB1021	6
15,16,51,52	Comp, 4.7 kΩ ±10%,¼ W	RC104-247	A-B	CB4721	4
17,32,53,66, 83,117,118	Comp, 470 ohm ±10% ¼ W	RC104-147	A-B	CB4711	7
18,31,54,65	Comp, 2 kΩ ±5%,¼ W	RC103-220	A-B	CB2025	4
19,25,26,34, 55,57,58, 60,67,68	Comp, 1 kΩ ±5%,¼ W	RC103-210	A-B	CB1025	10
20,33	Comp, 620 ohm ±5%,¼ W	RC103-162	A-B	CB6215	2
22,23,36,37	WW, 1 ohm ±5%, 5 W	RM104-R10	SPR	243E1R05	4
24,59	Comp, 2.7 kΩ ±5%,¼ W	RC103-227	A-B	CB2725	2
27,61	Comp, 220 ohm ±5%,½ W	RC105-122	A-B	EB2215	2
28,62	Comp, 1 kΩ ±10%, 2 W	RC110-210	A-B	HB1021	2
29	WW, 50 ohm ±5%, 10 W	RM103-050	SPR	247E5005	1
30	WW, 1 ohm ±5%, 10 W	RM103-R10	SPR	247E1R05	1
39,40,90	Comp, 2.2 MΩ ±10%,¼ W	RC104-522	A-B	CB2251	3
42,105	Var Cermet, 1 MΩ	RP131-510	CTS	360T105	2
43	Comp, 470 kΩ ±10%,½ W	RC106-447	A-B	EB4741	1
47,112	Var Cermet, 250 kΩ	RP131-425	CTS	360T254	2
49	Comp, 27 kΩ ±10%,¼ W	RC104-327	A-B	CB2731	1
56,69	Comp, 3 ohm ±5%, 1 W	RC107-R30	A-B	GB30G5	2
63	WW, 200 ohm ±5%, 10 W	RM103-120	SPR	247E2015	1
64	WW,5 ohm ±5%, 3 W	RM102-R50	SPR	242E5R05	1
70	Comp, 430 ohm ±5%,½ W	RC105-143	A-B	EB4315	1
71	Comp, 220 ohm ±5%, 2 W	RC109-122	A-B	HB2215	1
72	Comp, 120 ohm ±5%, 2 W	RC109-112	A-B	HB1215	1
81	Comp, 15 kΩ ±10%, 2 W	RC110-315	A-B	HB1531	1
88,89	Comp, 220 kΩ ±10%,¼ W	RC104-422	A-B	CB2241	2
91,121,122	Comp, 220 ohm ±10%,¼ W	RC104-122	A-B	CB2211	3
96,98	Comp, 150 ohm ±10%, 2 W	RC110-115	A-B	HB1511	2
97,99	Comp, 3.3 kΩ ±10%,¼ W	RC104-233	A-B	CB3321	2
100	Comp, 2.7 MΩ ±5%,½ W	RC105-527	A-B	EB2755	1
101	Comp, 910 kΩ ±5%,¼ W	RC103-491	A-B	CB9145	1
103	Comp,330 kΩ ±5%,¼ W	RC103-433	A-B	CB3345	1
104	Comp, 1 MΩ ±10%,½ W	RC106-510	A-B	EB1051	1
113*,114*	Value selected by factory				2
115,119	Comp, 1.5 kΩ ±10%,¼ W	RC104-215	A-B	CB1521	2
116,124	Comp, 390 ohm ±10%,¼ W	RC104-139	A-B	CB3911	2
120	Var Cermet, 10 kΩ ±20%	RP131-310	CTS	360T103	1
123	Comp, 1.2 kΩ ±10%,¼ W	RC104-212	A-B	CB1221	1

PARTS LIST

MODEL 1951 Main Board REV A

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
R "	RESISTORS (Cont'd)				
25	Comp, 2.2 kΩ ±10% ¼ W	RC104-222	A-B	CB2221	1
26	Comp, 15 kΩ ±10% ½ W	RC106-315	A-B	EB1531	1
27	Comp, 3.9 kΩ ±10% ¼ W	RC104-239	A-B	CB3921	1
S "	SWITCH				
	DPDT Slide Switch	SS000-001	C-W	G-126	1

PRELIMINARY

PARTS LIST

A309-1 HIGH VOLTAGE REV

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"C 200"	CAPACITORS				
1	Electrolytic, 10 µF +150 -10% 50 V	CE107-010	SPR	TE-1304	1
2	Electrolytic, 50 µF +150 -10% 50 V	CE107-050	SPR	TE-1307	1
3	Electrolytic, 100 µF +150 -10% 25 V	CE105-110	SPR	TE-1211	1
6	Mylar, .15 µF ±10% 100 V	CP103-415	CDE	WMF01P15	1
4	Mylar, .22 µF ±10% 200 V	CP101-422	CDE	WMF-2P22	1
5	Mylar, .1 µF ±10% 200 V	CP101-410	CDE	WMF-2P1	1
8,9,10,11	Ceramic Disc, 560 pF ±20% 6 kV	CD111-156	A-E	6CCD561	4
7	Ceramic Disc, .01 µF ±20% 1 kV	CD102-310	SPR	5GA-S10	1
"CR 200"	DIODES				
1	Silicon, Junction, 100 PIV	DR000-001	DIO	1N4004	1
2,3,4,5,6	Silicon, High Voltage 7000 PIV 10 mA	DR000-010	SEM	SCM70	5
"J 200"	CONNECTORS (JACKS)				
1	6 Pin Harness Connector	MC000-076	MOL	09-50-3061	1
	Contact, for above	MC000-068	MOL	08-50-0107	5
"Q 200"	TRANSISTORS				
2	NPN, Silicon, Darlington	QB000-025	MOT	MJE803	1
3	NPN, Silicon	QB000-023	MOT	MJE242	1
1	NPN, Silicon, Darlington	QA053-060	G-E	2N5306	1
"R 200"	RESISTORS				
1	Composition, 12 ohm ±10% ½ W	RC106-012	A-B	EB1201	1
2	Composition, 10 Kilohm ±10% ¼ W	RC104-310	A-B	CB1031	1
3	Wire Wound, 100 ohm ±5% 5 W	RM104-110	SPR	243E1015	1
5	Composition, 3.9 Kilohm ±10% ¼ W	RC104-239	A-B	CB3921	1
4	Composition, 220 ohm ±10% ¼ W	RC104-122	A-B	CB2211	1
"T 200"	TRANSFORMERS				
1	Transformer, High Voltage	TT002-028	W-I	TT000-028	1
	MISCELLANEOUS				
	High Voltage Lead Assembly	MC000-060	N-T	239-12	1
	Teflon Turret Terminals	HT115-000	SEL	RSTSM21-TUR	5

PARTS LIST

Model 1951 Chassis

REV A

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"J 300"	CONNECTORS				
1	BNC	JB106-250	APL	UG625/U	1
	CRT Socket	MC000-061	A-P	321-7	1
"Q 300"	TRANSISTORS				
1	PNP, Si	QB000-030	T-I	TIP36C	1
2	NPN, Si	QB000-029	T-I	TIP35C	1
3	PNP Si, Power, Darlington	QB000-024	MOT	MJE703	1
4	NPN Si, Power, Darlington	QB000-025	MOT	MJE803	1
"R 300"	RESISTORS				
1	WW, 10 ohm 50 W	RM105-010	OHM	0400B	1
2	Var Carbon, 20 kΩ	RP124-320	A-B	WA2G032S-203MA	1
"V 300"	TUBE				
1	CRT, 12" Rect. P1 phosphor	VV001-004	W-I	VV001-004	1
"L 300"	INDUCTORS				
1	Deflection Yoke	LY000-001	W-I	LY000-001	1
	SUPPLIED WITH UNIT				
	15 pin Harness Connector	MC000-081	MOL	09-50-3151	1
	Contacts for above	MC000-068	MOL	08-50-0106	15
	3 pin Socket	MC000-085	MOL	03-06-1032	1
	Contacts, Female for above	MC000-042	MOL	1561	3

PARTS LIST

Model 1951 Power Supply

REV A

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"C 400"	CAPACITORS				
1,2	Elect, 9500 µF, 50 V	CE117-295	MAL	CG952U-050EFH3	2
3,4	Elect, 20 µF, 250 V	CE109-020	C-D	BR20-250	2
"CR 400"	DIODES				
1,2,3,4	Si, Junction 200 PIV 3 amp	DR000-009	G-E	1N5624	4
5,6	Si, Junction 400 PIV 3/4 amp	DR000-001	DIO	1N4004	2
"F 400"	FUSE				
1	2 amp slo-blo for 110 V operation	MF000-002	BUS	MDL2	1
"P 400"	CONNECTORS (PLUGS)				
1	3 pin plug	MC000-084	MOL	03-06-2031	1
	Contacts for P401 & P402	MC000-041	MOL	1560	7
2	5 pin plug	MC000-086	MOL	03-06-2054	1
	Contacts for above	MC000-019	MOL	1854	1
"R 400"	RESISTORS				
1	Comp, 2.2 kΩ ±10%, ½ W	RC106-222	A-B	EB2221	1
"T 400"	TRANSFORMER				
1	Transformer, Power	TT000-026	W-I	TT000-026	1

MANUAL CHANGES

All Ocilloscopes

WAVETEK'S product improvement program incorporates the latest electronic developments into these instruments as rapidly as development and testing permit. Due to the time required to document and print these instruction manuals, it is not always possible to include the change information in the current printing. The following changes should be made to this manual:

CHANGES

1). Due to vendor changes, the wire connecting the CRT cathode and TP7 may be either a grey or a yellow wire. If a grey wire is used, no yellow wire will be present. If a yellow wire is used, no grey wire will be present.

2). On the CRT itself, pins 1 and 5 are internally shorted together, and either may be used to connect the CRT grid to the blanking cirucit.

MP MASTER
MA21632